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Assessing Children's Legs and Feet

SUMMARY

Shoes are necessary for protection and warmth. Normal children do not require shoes for support. There is no scientific evidence that shoes—'orthopedic' or otherwise—influence or alter the growth or shape of the normal child's foot except, perhaps, adversely if they fit poorly. Family physicians must understand common variations of normal foot and leg development if they are to effectively advise and reassure parents about appropriate footwear. Flat feet, knock knees, bow legs, in-toeing, and out-toeing in otherwise normal children can easily be distinguished from similar but more serious deformities associated with disease or congenital anomaly. (Can Fam Physician 1985; 31:595-598).

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SOMMAIRE

Les chaussures sont nécessaires pour leurs qualités de protection et de chaleur. Les enfants normaux n'ont pas besoin de support. Il n'y a pas d'évidence scientifique que les chaussures—"orthopédiques" ou autres—influencent ou modifient la croissance ou la forme du pied de l'enfant normal, sauf peut-être une influence défavorable si leur ajustement n'est pas adéquat. Les médecins de famille doivent comprendre les variations courantes du développement normal du pied et de la jambe s'ils veulent conseiller et rassurer efficacement les parents sur le port de chaussures appropriées. On peut facilement distinguer les pieds plats, les genoux cagneux, les jambes arquées, le hallus valgus et les orteils en varus chez des enfants par ailleurs normaux, de difformités semblables mais plus sérieures, associées à une maladie ou une anomalie congénitale.

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SOCIETY'S PREOCCUPATION with expensive footwear for children is difficult to reconcile with knowledge of the foot's anatomy, growth, and function. The softness, and pliability of an infant's foot, plus ignorance about normal development and later variations from normal, are two factors leading to excessive concern with proper shoes for children.

Shoes have traditionally been the most expensive item in a child's wardrobe. In less prosperous times, most families could not afford footwear generally regarded as proper. Consequently, parents passed shoes from one child to the next, fearing that if the younger child's feet were not identical, they would have problems later. Also, a significant number of adults with corns, callouses, hammertoes, and bunions believe these resulted from improper shoes in childhood. In fact, these conditions are due to placing adult feet into fashionable, ill-fitting, footwear that does not conform to the foot's normal shape (see Figure 1).

The ability to provide each child with proper shoes or boots and to replace them frequently at one time reflected prosperity and demonstrated appropriate parenting. The shoes, rather than normal development, were given credit for the foot's eventual favorable shape and function.

The Concept of 'Normal Variation'

Parents readily accept variations in facial features and body habitus among their children. However, they do not so easily accept variations in foot shape, leg alignment, or the foot progression axis while walking. When counselling parents, put the problem in perspective by explaining that variations in legs and feet are not unlike more obvious variations (e.g., in facial features). Some children have slightly bowed legs, others knock knees. Some walk with their toes pointing in, others pointing out. Parents should expect the same variation in feet as in any other biological system. What constitutes the ideal is purely a value judgment. This point should be obvious to all but, unfortunately, it is not. Parents have been mistakenly led to believe that there is a simple shoe correction for each variation, which will make children's legs and feet perfect.

The Assessment

A concise but focussed history is essential. Enquire about the perinatal history, developmental milestones, general health and family history to rule out most neuromuscular disorders such as cerebral palsy. Enquire about symptoms such as pain, tripping or fatigue. Seek out the source of concern, whether it be the posturing of the legs in the neonatal period, a grandmother, an aunt who is a nurse or a physiotherapist, or a relative in the shoe business.

The most common complaint is 'flat feet' or 'fallen arches'. Pigeon-toe deformity and angular appearances such as bow legs or knock knees are close behind. Frequently, parents assume that repeated tripping or poor athletic performance are due to the shape of the legs or feet.

Begin the examination by observ-

ing the child's gait, if walking age has been reached. Next, look at the back for scoliosis, hairy patches or skin dimples, which may be external manifestations of underlying spinal anomalies. Observe the alignment of the legs, with the child both standing and supine. Note the distance between the medial femoral condyles and the medial malleoli. Have the child stand on tiptoes or, if uncooperative, partially suspend the child by the trunk so you and the parents may visualize the reconstitution of the foot's longitudinal arch, as the ankle and foot flexor muscles contract. With the child supine, move the hips through a range of motion, particularly noting the adequacy of abuduction. Note muscle bulk and tone while examining the other major joints' range of motion. Determine the range of dorsiflexion of the ankles, taking care to hold the heels in neutral valgus/varus to avoid missing heel cord tightness. Elicit reflexes and plantar responses, and measure legs from the anterior superior iliac spines to the lateral malleoli.

Next, assess rotation of the hips in extension, using the patella as a crude protractor. Excessive internal rotation and limited external rotation suggests femoral anteversion or internal femoral torsion. With the patella facing directly superiorly and the knees extended, note the relationship of the medial and lateral malleoli and the direction of the foot's longitudinal axis. A lateral malleolus anterior to the medial or a medially directed foot suggest internal tibial torsion. Observe the soles to see if the foot's lateral border curves inwards, suggesting metatarsus varus (adductus). If this finding is present, gently manipulate the foot to see if this is passively correctable.

Complete the examination by having the child rise from a sitting or kneeling position without using the hands (Gower's test). Most normal children of walking age should be able to do this. If not, suspect muscle weakness.

Interpretating the Assessment

The most common complaints or concerns are flat feet, in-toeing (pigeon toe deformity, bow legs (genu varum), knock knees (genu valgum), and out-toeing.

Flat feet

All normal infants' and toddlers' feet are flexible and thus appear flat. In infancy the plantar fat pad accentuates the flattened appearance. When the child cruises around furniture, the strength and tone of the muscles responsible for forming the longitudinal arch are not activitated sufficiently to give the normal stance configuration of the feet. Also, toddler ligaments tend to be lax. Standing unsupported is more a proprioceptive than a muscular function. The normal longitudinal arch results from the interaction of extrinsic and intrinsic foot muscle activity. Even during the mid-stance phase of gait, the lower leg muscles are relatively inactive when measured by electromyography. All these factors combine to produce a flexible foot, with lax ligaments and little muscle activity, that appears flat.

The demonstration of arch reconstitution on toe standing should satisfy most parents that the feet are, in fact, *not* flat. It may even be necessary to have one or both parents participate in the demonstration (see Fig. 2).

The interpretive part of the examination includes distinguishing rigid

Fig. 1A A 16-year-old girl with a painful adolescent bunion. Note early hammer toe deformity in the lateral two toes. Will the foot fit in the shoe shown in the figure?

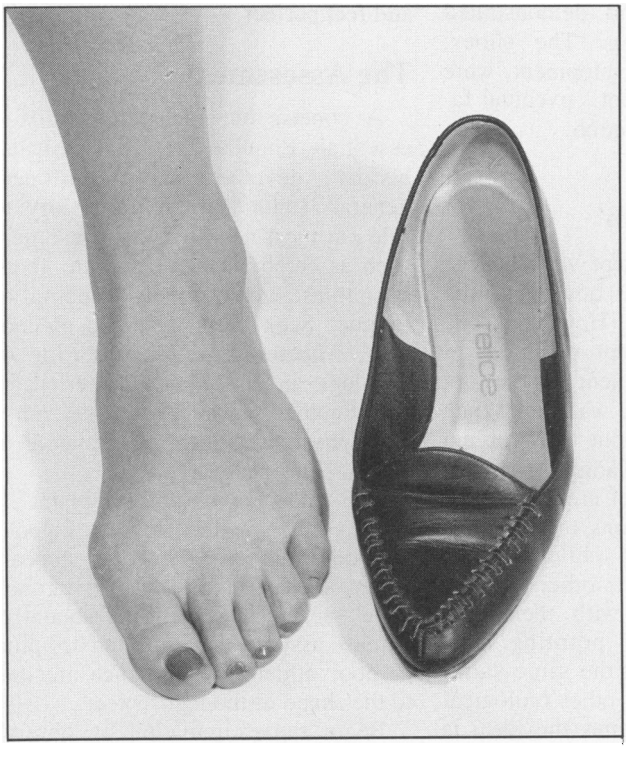
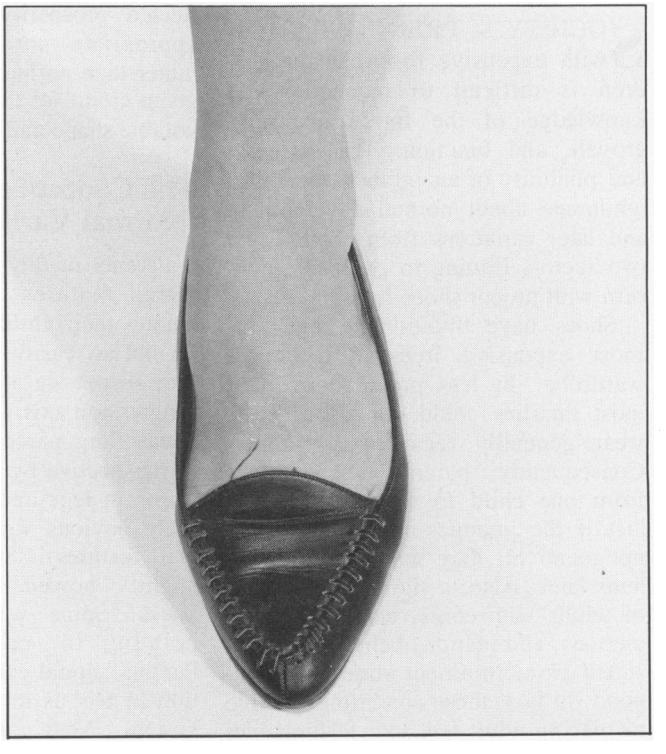


Fig. 1B The answer! It doesn't take much medical knowledge to predict that this type of shoe will aggravate the deformity and leads to forefoot stiffness and pain.



from flexible flat feet and identifying problems remote from the foot that are responsible for the appearance. For example, tarsal coalition, a condition where there is initially a cartilaginous and later a bony connection between the bones of the hind foot, may lead to peroneal muscle spasm and a painful, rigid flat foot. Tight tendo-achillis may lead to apparently flat feet, because the heel rolls into valgus and the mid-foot pronates to effect a plantigrade foot, in an attempt to escape the heel cord contracture.

Patients with rigid flat feet or high arched feet (cavus feet) are more likely to have pain than children with flexible flat feet. Shoes with arch supports, scaphoid 'cookies', or extended Thomas heels do not significantly alter flexible flat feet. Due to the factors contributing to flexible flat feet, it is not rational to expect 'orthopedic' shoes to change the contour of the longitudinal arch. Flexible flat feet appear to improve with age, as ligaments become less distensible, not because of some mythical benefit of special shoes.

The occasional older child with pain associated with flexible flat feet, on strenuous exercising, may be helped by orthotic shoe inserts which lift the heel out of valgus and support the longitudinal arch. However, these should be custom made from molds taken of the feet effecting total contact with the area requiring support. Built-in shoe correction alone is not adequate. Since these orthotic devices are usually made of fairly rigid plastic and therefore awkward to wear during sports, children will not wear them unless they are having sufficient pain.

In-toeing

Parents are concerned about future cosmetic and functional consequences of in-toeing. In-toeing resolves spontaneously in most otherwise normal children; even if it does not, there are no proven serious consequences of a pigeon-toed gait. Parents may complain that the child trips a lot, but this is a subjective observation. Children learn by practice, and they soon discover when they are exceeding the limits of their agility. Pigeon toes do not lead to demonstrably poor athletic performance later.[1]

Metatarsus varus (adductus) usually presents from birth to one year of age. It is important to distinguish fixed from flexible deformity. Most are flexible and will resolve by two to three years of age. Fixed or rigid deformities are often accompanied by a vertical crease on the medial border of the foot. These require referral to an orthopedic surgeon. While straight last or out-flare shoes may have some small influence, they are more likely to produce secondary deformity.

Internal tibial torsion is noted from eight to ten months until three years. It is due to intrauterine molding, maintained by the infant's sleeping posture, and spontaneously resolves in 90% of patients,[2] usually by three to four years of age. Cases that do not resolve by age four may be corrected by shoes externally rotated on a Denis-Browne bar, worn at night. If parents cannot be reassured, the bar can be used when the child is younger, but they should be told that the treatment is mainly for *their* benefit, and that the bar should not be given credit for what normal development would accomplish.

Internal femoral torsion (femoral anteversion) becomes apparent at three to five years of age, when the legs have completed their medial rotation from the externally rotated and flexed neonatal position. Femoral anteversion tends not to resolve as quickly or completely as flexible metatarsus varus or internal tibial torsion.[3] There will be some true correction until age seven or eight. The remainder of the in-toeing will be compensated for by the development of external tibial torsion during adolescence, when appearance becomes important to children and they make a voluntary effort to walk straight. Parental nagging to walk straight before then is ineffective, harmful to the child's self-image, and may damage other aspects of the parent-child relationship.

Fig. 2A A 14-year-old boy and his father, both with 'flat feet' and valgus heels. Both were asymptomatic; the father had done heavy manual labor all his adult life and the boy excelled in athletics. The father said he brought the boy for orthopedic consultation because 'My mother-in-law insisted that something be done to correct the boy's deformed feet while something could still be done about it!'

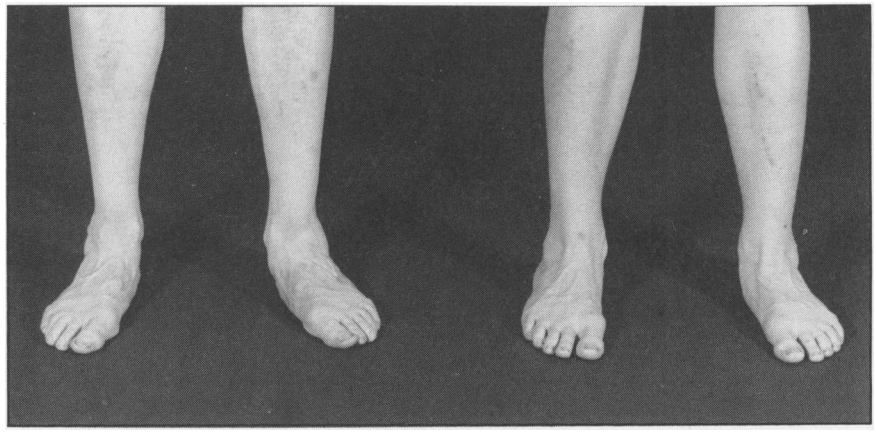


Fig. 2B Reconstitution of the longitudinal arches and normal heel alignment on toe standing. These are flexible rather than flat feet, presumably inherited.

Neither heel or sole wedges on the shoes, nor built-in corrections have any signficant influence on internal tibial or femoral torsion.[4] It is not reasonable to assume that shoe correction will have any influence on leg growth because any 'corrective' force will be absorbed by the foot's mobile joints.

Bow legs

Physiologic bowing (genu varum) is common in precocious and heavy infants. Those who stand at an early age are more likely to have bow legs. In an otherwise healthy child, genu varum universally resolves spontaneously by 30 months to three years of age. It should be distinguished from rare causes such as nutritional or inherited rickets and Blount's disease, which is a rare dysplasia of the medial portion of the proximal tibial epiphysis, seen most frequently in black children. If corrective shoes are prescribed, they will recive the credit for Nature's correction.

Knock knees

Knock knees (genu valgum) are usually associated with lax ligaments. The legs are normally aligned in 5-10° of valgus in adults. It may seem excessive in girls or in boys with a wide pelvis. The appearance is aggravated because children normally have prominent medial femoral condyles. Muscular development plus the usual tightening of ligaments eventually give the legs normal appearance. Concern is not warranted unless there are more than four fingerbreadths between the medial malleoli when the child stands with knees together.

Once again, there is no evidence that corrective shoes influence the natural history of this common variation from normal.

Out-toeing

There are two explanations for this pattern of leg alignment. The first is calcaneovalgus, where the dorsum of the foot is forced up against the shin as a result of intrauterine position. This is often described as the reverse of the club foot but is, in fact, as benign as the club foot is serious. The club foot is a fixed deformity, whereas calcaneovalgus is usually passively correctable. There are rare causes of fixed calcaneovalgus (meningomyelocele, congenital vertical talus), but these are readily distinguished by their fixed structure. Flexible causes almost always correct without treatment but may cause toeing-out when the child begins to stand.

The second cause for toeing-out is the normal external rotation contracture of the hip in infancy. The legs grow and take adult alignment in response to the stresses applied to the growth plates. This mechanism directs epiphyseal growth. Out-toeing spontaneously improves by 18 months to two years.

Anatomy of the Shoe

The last is the mold over which shoes are made, and therefore determines their shape. A description of the last's shape describes the shoe's shape (e.g., straight last shoe). The shoe itself consists of an upper and a sole. The portion of the upper which fits around the heel is the counter. The sole is made up of the insole, the outsole, and a filler between. The shank area of the sole extends through the mid part of the foot from approximately the middle of the heel to mid metatarsal area. When leather was the main material of shoes, the welt was the edge from the upper, stitched in a variety of patterns, to be both insole and outsole to hold the shoe together. The lining was formerly cloth but now, highly absorbent synthetic materials are used more frequently.

This perhaps over-simplified description is essential knowledge for family physicians, if they are to converse with parents who have some knowledge of shoe design and construction. One of the problems with European and North American shoe designs is that the last is curved inward, and does not conform to the straighter, longitudinal axis of a child's foot.[5] This causes the fifth metatarsal and lateral toes to be constricted in many shoes. Sim-Fook and Hodgson[6] confirmed this impression in a Hong Kong study comparing the barefoot and shoe-wearing populations. They found that foot mobility diminished and foot deformity increased with shoes. They also found that when the foot became restricted by shoes, its natural form was altered and static deformities and symptoms developed.

Counselling Parents About Footwear

It is inappropriate to tell parents that there is nothing wrong with their child or to abruptly send them on their way with a prescription for orthopedic shoes. Parents are naturally concerned that the foot or leg configuration may limit their child's physical potential or worse, lead to foot problems or even arthritis later on. It takes only a few minutes to explain the concept of normal variation, the absence of proof that later unfortunate consequences will ensue, and that the apparent problem will not affect athletic performance.[1]

I tell parents that shoes are necessary for protection and warmth. Normal children do not require shoes for support. The shoe will eventually conform to the foot. Children do not require shoes until walking age or shortly after (12-18 months). There is no advantage to ankle boots over shoes except that boots may stay on the toddler's chubby and mobile feet better, and they are more difficult for the child to remove. In fact, boots offer very little additional support. Arch supports are unnecessary.

Shoes should be wide and long enough to accept the foot without constricting it (a thumbsbreadth between the great toe and the front end of the shoe), and inexpensive enough that new ones can be bought as the child grows. Beyond this advice, the type of shoe depends upon fashion, personal preference, and affordability. In children who break down shoes quickly, sturdier, more expensive shoes with a firm heel counter and stiffer sole may cost less over time because they last longer.

To my knowledge, there is no scientific evidence that shoes, 'orthopedic' or otherwise, influence or alter the growth or ultimate shape of the normal child's foot — except perhaps adversely, if they fit poorly. ◉

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